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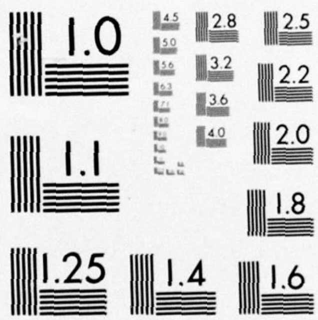
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AIR FORCE HUMAN RESOURCES LABORATORY

CLASSIFICATION TYPOLOGY FOR PREDICTING PERFORMANCE IN AIR FORCE TECHNICAL TRAINING

By

Dickie A. Harris, Capt, USAF

TECHNICAL TRAINING DIVISION
Lowry Air Force Base, Colorado 80230

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

NOTICE

This final report was submitted by Technical Training Division, Air Force Human Resources Laboratory, Lowry Air Force Base, Colorado 80230, under project 1121, with HQ Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235.

This technical report has been reviewed and is approved for publication.

MARTY R. ROCKWAY, Technical Director
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DAN D. FULGHAM, Colonel, USAF
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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

This study showed that technical training students could be classified into potential instructional groups, using linear typal analysis. However, the operational and practical consequences of using linear typal analysis were not demonstrated in this study. Further study was suggested in order to determine the practical significance of grouping individuals into instructional groups, based on linear typal analysis.

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SUMMARY

Problem

With the advent of the Advanced Instructional System (AIS) and its capability for individualized presentation of materials, a method of classifying individuals into instructional groups was needed. This effort was designed to develop and evaluate a method for empirically determining a classification typology for students entering technical training.

Approach

The study was done in two phases. The first phase was concerned with the development of a classification structure using the similarity of individual's scores. The second phase was devoted to an evaluation of the classification structure developed in Phase I. Individuals were placed into the empirically derived groups and a statistical assessment of the classification structure was made using multiple discriminant analysis.

Results and Conclusions

It was demonstrated that there are definable groups which are significantly different. However, the operational significance of these differences was questioned since the course performance of the groups was not significantly different. It was concluded that groups could be formed empirically but that further research was necessary to discover the instructional strategies which would be most appropriate for individual groups.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

CLASSIFICATION TYPOLOGY FOR PREDICTING PERFORMANCE
IN AIR FORCE TECHNICAL TRAINING

I. INTRODUCTION

The Advanced Instructional System (AIS) is an advanced development program to develop a computer-based training system for the Air Force. The heart of the system is a Control Data Corporation (CDC) Cyber-70 which currently manages the training process for four courses at Lowry Technical Training Center, Lowry AFB, Colorado, through the so-called type A and B terminals. The type A terminal is an interactive plasma display terminal with graphic capabilities, while the type B terminal has test form reading and scoring capabilities along with a line printer for issuing student prescriptions. The system is designed to manage the individualized instructional process of a large number of students using an adaptive model which employs multiple regression equations to assign students to instructional modules or strategies on an individual basis. The major instructional modules consist of audio visual, black and white illustrated texts, color illustrated texts, programmed texts, and video tape presentations. It was felt that the assignment of instructional modules might become more economic, if a method for classifying incoming students into instructional strategy groups was devised. That is, the number of computer analyses and the complexity of the computer software needed to support the adaptive model could be greatly reduced if students were grouped rather than having individual predictions for each student.

Overall and Klett (1972) presented a method of studying relationships of observed individuals to underlying pure types. This method (i.e., linear typal analysis) assumed that underlying any heterogeneous group of individuals were a relatively few basic pure types. Therefore, the aims of linear typal analysis were to discover the nature and number of underlying pure types, to define a prototype vector to represent each pure type, and then to determine the similarity of each individual to each of the hypothetical pure types. If most individuals could be recognized as being highly similar to one and only one of the underlying pure types, a classification grouping could be accomplished by assigning each individual to the class represented by the pure type having a profile most similar to his own. The objective of this study was to use linear typal analysis to empirically develop a classification typology for students entering technical training. The study was carried out in two phases. The first phase was devoted to developing a classification grouping of technical training students using linear typal analysis. The second phase was devoted to an evaluation of the classification grouping developed in phase one.

II. METHOD

Subjects

The subjects for this study were 366 students enrolled in the Electronic Principles (Modular Self-Paced) course at Lowry Technical Training Center. The students were first-term airmen that had just completed basic military training.

Procedure

The data were collected from historical records furnished by the Electronic Principles (EP) course. The data were collected over a nine-month period beginning in January 1974.

The variables used to develop the pure type profiles were: (a) Armed Services Vocational Aptitude Battery (ASVAB)/Airman Qualifying Examination (AQE) general, (b) ASVAB/AQE electronic, (c) ASVAB/AQE mechanical, (d) ASVAB/AQE administrative, (e) average aptitude index Armed Forces Qualification Test (AFQT), (f) a mathematic pretest developed by EP course personnel, and (g) the Nelson-Denny Reading Test. The ASVAB/AQE contains multiple-choice questions on nine subtests; these subtests are grouped and scored to yield the four aptitude indexes and the average aptitude index.

The variables, described in the preceding paragraphs, were used as input for the linear typal analysis (LTA). The LTA defined the pure type profile vectors and assigned each of the 366 subjects to one of the pure types. A multiple discriminant analysis (MDA) was then used to test for differences between the profiles on the aptitude and performance variables.

III. RESULTS

Linear Typal Analysis

The results of the LTA are presented in Table 1. The LTA profiles defined three pure types. The largest differences were between Profile I and Profile II. Profile III did not seem to be much different from Profile I.

To test the differences between the profiles, the subjects were classified into three groups based on the similarity of their scores to the three prototype vectors. As a result of this classification analysis, 150 subjects were assigned to Group I, 130 subjects were assigned to Group II and 86 were assigned to Group III.

Multiple Discriminant Analysis–Phase I

An MDA was performed on the data. The resulting Wilks' lambda criterion (λ) (Tatsuoka, 1971) for the discriminating power of the profile variables to separate the three groups indicated the probability was essentially zero that group differences as large or larger than those obtained would be produced by chance. In Table 2, it can be seen that 100 percent of the trace was accounted for by the two discriminant functions. The eigenvectors, presented in Table 3, are coefficients of the discriminant functions. These discriminant weights indicated the consequential contributors to group separation along the first and second functions.

MDA Phase I Discussion

The previous statistics suggested the following interpretations. First, the linear typal analysis was sensitive enough to separate significantly three groups of EP students into classification profiles. Secondly, the total discriminatory power of the classification variables was accounted for by two mutually orthogonal functions. The relative sizes of their eigenvalues established the extent to which the discriminant functions distinguished among the profiles. The degree of importance attached to each of these functions in explaining the differences among the profiles had been estimated by the percentage of the trace attributed to each of these functions. Consequently, the first function was considered to be more important than the second function for simplifying profile separation. Lastly, the group centroids computed relative to the functions were separated from each other to a maximum degree. Considering the two discriminant functions as axes of a Cartesian coordinate system, the group centroids were plotted with reference to these axes in Figure 1. It can be seen that discriminant Function I separated Profile I and Profile II, but did not separate Profile I and Profile III to a great extent.

Multiple Discriminant Analysis–Phase II

The next step in the analysis was to repeat the multiple discriminant analysis using performance variables that were associated with the three profiles. The performance variables were: (a) retraining hours (RH), (b) average course grade (AG), (c) number of blocks failed (BF), and (d) the number of hours taken to complete each of the ten blocks (BT 1–10). The resulting Wilks' lambda criterion (λ) for the discriminating power of the performance variables to separate the three groups indicated that the group differences as large or larger than those obtained were not significantly different from chance (see Table 4). One hundred percent of the trace was accounted for by the two discriminant functions. The eigenvectors presented in Table 5 are the coefficients of the discriminant functions. These discriminant weights indicated the consequential contributors to group separation along the first and second functions.

MDA Phase II Discussion

The previous statistics led to the following interpretations. First, the three groups defined by the linear typal analysis did not differ significantly from each other on performance in the electronic principles course. Secondly, the total discriminatory power of the performance variables was accounted for by two mutually orthogonal functions neither of which was able to significantly separate the three groups. Lastly, since the group centroids computed relative to the functions were separated from each other to a maximum degree, the lack of a significant difference between the group centroids was interpreted to mean that the groups did not differ in performance in the course (see Table 6). Again considering the two discriminant functions as axes of a Cartesian coordinate system, the group centroids were plotted with reference to these axes in Figure 2. It can be seen that neither discriminant function successfully separated the three groups.

IV. CONCLUSIONS

The results of this study showed that linear typal analysis can be used to develop a classification typology of technical training students. The multiple discriminant analysis of the three groups, defined by the LTA, showed that the profiles defining each group were significantly different. This result lent support to the assertion that there are a relatively few basic pure types underlying any heterogeneous group. Based on the results of the first discriminant analyses, it was expected that the three groups would also differ in their performance in the course. However, the results of the second discriminant analysis did not support this hypothesis.

It should be remembered, however, that the data analyzed in this study were historical rather than experimental. That is, the data were compiled from student records and no experimental treatment was applied to the three groups. The results may have been quite different if each of the groups, defined by the linear typal analysis, had been assigned to a different instructional strategy.

Another point which should be raised is that a linear typal analysis does not suggest which instructional strategy is appropriate for which profile. The linear typal analysis tells us that there are definable groups, but further experimentation is needed to match those groups with the appropriate instructional strategy.

In conclusion, this study showed that technical training students could be classified into *potential* instructional groups using linear typal analysis. However, the operational and practical consequences of using linear typal analysis were not demonstrated in this study. A controlled experiment is needed to determine the practical significance of grouping based on linear typal analysis by assigning various instructional strategies to the groups and observing the effects on course performance.

Table 1. **Pure Type Profiles for Electronic Principles Students (N = 366)**

Variable	Profile I	Profile II	Profile III
ASVAB/AQE General	76.4	81.7	72.3
ASVAB/AQE Electronic	86.8	80.8	81.7
ASVAB/AQE Mechanical	80.1	58.2	78.8
ASVAB/AQE Administrative	57.7	71.9	59.3
AFQT	79.7	77.6	83.3
Math Pretest	72.3	75.9	68.0
Reading Ability[a]	10.5	12.6	11.4

[a]Reading ability corresponds to grade level equivalent. All the other variables are expressed as percentiles.

Table 2. **Significance of the Discriminant Functions χ^2 Approximations (Phase I)**

Function	Percent of Trace	Eigen-Values	df	χ^2	P
1	91.4	1.42	14	363.5	.000
2	8.6	.13	6	45.0	.000

Table 3. **Discriminant-Function Weights for Each Profile Variable (Phase I)**

Variable	Function I	Function II
ASVAB/AQE General	−.0244	−.0271
ASVAB/AQE Electrical	.0593	−.0688
ASVAB/AQE Mechanical	.0562	.0360
ASVAB/AQE Administrative	−.0311	.0134
AFQT	.0035	−.0457
Math Pretest	−.0023	−.0013
Reading Ability	−.2228	.2100

Table 4. **Significance of the Discriminant Functions χ^2 Approximations (Phase II)**

Function	Percent of Trace	Eigen-Values	df	χ^2	P
1	68.1	.065	26	33.24	.155
2	31.9	.030	12	10.72	.553

Table 5. **Discriminant-Function Weights for Each Performance Variable (Phase II)**

Variable	Function I	Function II
1 RH	−.046	−.025
2 AG	.082	−.166
3 BF	.532	−.387
4 BT1	.071	.042
5 BT2	−.014	−.049
6 BT3	.0005	.024
7 BT4	.037	−.009
8 BT5	.074	.012
9 BT6	−.011	.007
10 BT7	.019	.031
11 BT8	−.012	.025
12 BT9	−.011	.019
13 BT10	.013	.011

Table 6. **F Matrix for Differences in Group Centroids**

Group	Group 1 (N=150)	Group 2 N=130)
2	1.323	
3 (N=86)	.914	1.64

NOTE: – df = 13,351

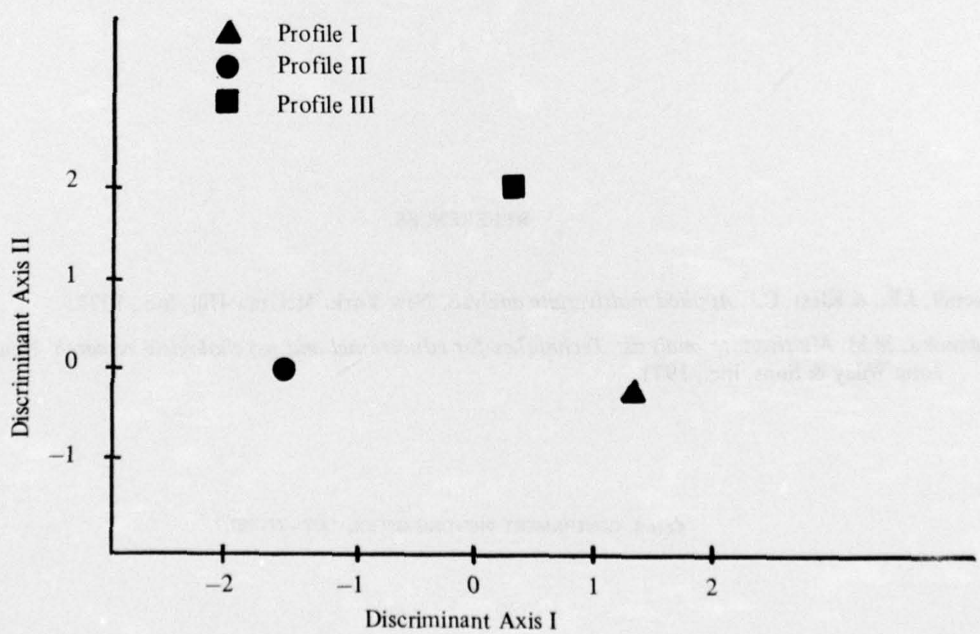

Figure 1. **Group centroids in the discriminant space.**

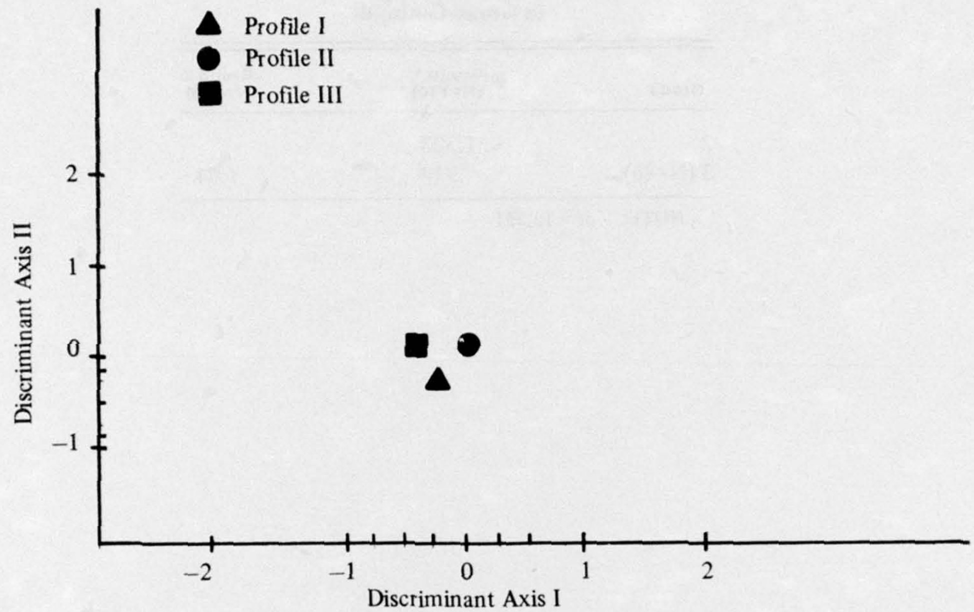

Figure 2. **Group centroids in the discriminant space (performance variables).**

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